Effect of X-Ray Radiation on the Survival of the Corn Leaf Aphid[1]

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The genetic composition and manner in which traits are passed from generation to generation is a most interesting problem in the corn leaf aphid, *Rhopalosiphum maidis* (Fitch). Although this insect was first described in 1856 by Fitch, the first report and description of the alate male was made by Wildermuth and Walters in 1932. These forms occurred during the winter months in reared cultures. So far as is known the male form does not occur in nature and oviparous females have never been reported.

Since this insect reproduces parthenogenetically and viviparously, it is to be expected that each daughter aphid would be genetically identical with the mother. However, Cartier and Painter (1956) reported the existence of two biotypes in populations of this aphid. Additional biotypes were isolated by Pathak and Painter (1958a, 1958b, and 1959). Ford and Everly (1960) observed two distinct color variants in cultures of the corn leaf aphid on sorghum which were identified as this species by Professor J. J. Davis. Since the absence of males precludes the introduction of variations due to chromosomal interchanges of genes, morphological variations and the development of physiologic races in this aphid must be due to a high sensitivity to mutagenic agents. The mechanism of this phenomenon is little understood.

To obtain information on the variability of this insect when subjected to a mutagenic agent, X-rays, it was necessary to determine the effects of different dosages on aphid mortality. An optimum survival with an opportunity for mutations to occur should approximate the dosage at which 50 percent of the aphids survived. To determine this LD50 dosage rate, colonies of the corn leaf aphid were subjected to a wide range of X-ray irradiation.

Methods and Materials

The aphids used in these tests were cultured on seedling barley plants in the greenhouse during the summer. No cooling facilities were available and consequently temperatures were quite high during August. This resulted in reduced reproduction and smaller individuals, similar to the observations of Wildermuth and Walters (1932). When the aphids had increased in numbers on the barley plants, a single heavily-infested plant was cut at ground level and immediately inserted in a water-filled "orchid" tube to prevent wilting and drying of the plant. The infested plant and tube were placed in a deep petri dish and covered. The dosage rate was marked on the side of the dish with a wax pencil. Seven of these infested plants were similarly prepared and taken within an hour to a nearby building where six were subjected to X-ray dosages ranging from 1000 to 32000 r-units by progressively doubling the dosage rate.

A General Electric Maxitron 300 X-Ray machine was used. The machine was calibrated to deliver 280 roentgen units per minute over a

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field sufficiently large to treat three petri dishes simultaneously. The times of exposure to produce the desired dosage rates are given in Table 1. The

Table 1. Exposure time needed to irradiate corn leaf aphids at varying dosage levels and survival of aphids after irradiation. Lafayette, Indiana. Summer 1961.

Dosage	Time of Exposure[1]	Irradiated Aphids Transferred	Aphid Survivals After 11 Days	
r-units	*Min.*	*No.*	*No.*	*%*
0	0	66	53	80.3
1000	3.6	103	120	116.5
2000	7.2	75	32	42.7
4000	14.3	68	8	11.8
8000	28.6	57	0	0
16000	57.3	44	3	6.8
32000	104.6	48	1	2.1

1. General Electric Maxitron 300 X-Ray machine delivered 280 r-units per minute.

dosage levels were selected to provide one sufficiently high to cause complete mortality and one low enough not to injure the aphids. Three samples were treated at one time, with each sample being removed when it had received the proper dosage. An automatic built-in timer controlled the exposure time. The untreated aphids received similar treatment as the others except they were not subjected to the X-rays.

Immediately following the completion of the treatments the colonies of aphids were returned to the greenhouse and transferred to flats of seedling sorghum plants, one aphid to a plant and only one dosage rate to a flat. These seedling sorghum plants were grown under cheesecloth to reduce the chance of contamination from other untreated aphids. After the plants were infested the cheesecloth was replaced. The cheesecloth also reduced the attack of predators and parasites. Daily observations were made and on the tenth day the plants were dissected and the numbers of aphids present recorded. (Table 1.)

Results and Conclusions

The percent of aphids surviving on the sorghum plants and the dosage rates were plotted on rectilinear, semi-log and double-log coordinate paper. When the data were plotted on the double-log paper the points fell in approximately a straight line indicating the relationship between the two variables was best expressed by the power log curve. The data were then converted to common logarithms and a straight line fitted with the formula $\log Y = 5.88025 - 1.29252 \log X$. The correlation was high significant, $r = 0.988$ compared with 0.917 required for high significance, with a highly significant b-value of —1.29. When the constants for the straight line are converted to the power log curve the relationship of the two variables was best expressed by the formula $Y = 759{,}000X^{-1.29252}$. (See figure 1.) Based on this relationship the LD50 was determined to be 1717.8 r-units.

This LD50 dosage rate has several inherent modifying factors as it is based on a heterogeneous-age population of aphids, ranging from newly-

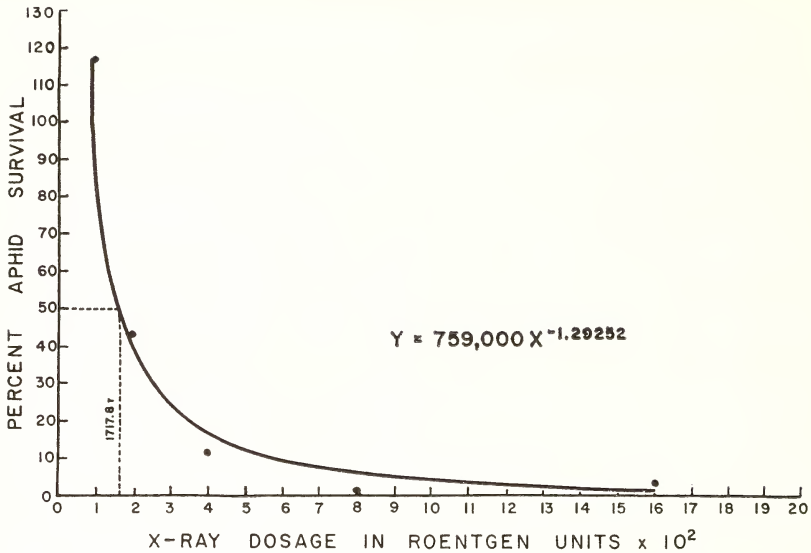

Figure 1. Effect of different dosages of X-radiation on the mortality of the corn leaf aphid in the greenhouse, Lafayette, Indiana. 1961.

born nymphs to reproductively-depleted adult females, although the large size of the irradiated colonies would tend to minimize the effect of age differences of the individuals comprising them. However, the LD50 of immature aphids might conceivably differ extensively from that of mature aphids. In addition the LD50 calculated from the surviving aphids after a period of 10 days represents a combined morphological and reproductive LD50.

For further studies on the sensitivity of the corn leaf aphid to mutagenic agents, the LD50 of approximately 2000 r-units will give sufficient survival and possibility of induced variations to make this a usable irradiation rate. The results of these studies indicate the need of further experiments along these lines to determine the effect of age on variability of morphological mortality as well as reproductive sterility.

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